ABSTRACTS

Session 28: Solar Theory
Display Session, Exhibit Hall

28.01
Particle Acceleration by Nonlinear Travelling Waves*
S. Mahajan and R.S. Steinolfson (U. Texas, Austin)

Analytic solutions of the fully nonlinear Vlasov-Maxwell set of
equations obtained recently by Mahajan (1988) are applied to the
acceleration of particles in solar flares. The time-dependent solutions
represent a system of charged particles (an electron-ion plasma)
coupled with their self-consistent electromagnetic fields. The ion and
electron distribution functions are given by Maxwellian distributions
displaced by the respective drift velocities and convected at the wave
velocity. The solutions are given in terms of a parameter that measures
the steepness of the wavefront. For representative coronal
thermodynamic conditions and magnetic field strength, particles can
easily be accelerated to speeds approaching that of light providing the
waves have time to steepen sufficiently. With some modifications, the
theory can be made relativistic. The mechanism has the advantage that,
given an adequate turbulent wave source, it is effective over the entire
energy spectrum. In addition, since the waveform propagates across
magnetic field lines, particles may be accelerated in open as well as
closed field configurations.

*Research supported by NASA, NSF and DOE.

28.02
Nonlinear Filamentation Instability*
R.S. Steinolfson (U. Texas, Austin) and R. Rosner (U. Chicago)

The spatial structure of the thermal instability is governed to a large
extent by the spatial behavior of the magnetic field. We study the
thermal mode in a dissipative medium containing a stratified magnetic
field. By concentrating on wavenumbers perpendicular to the field,
we can neglect parallel thermal conduction in an initially isothermal state
and only need consider the perpendicular component. The linear
stability analysis for the resulting filamentation instability has been
carried out by Bodo et al. (Astrophys. J. 313, 432, 1987). Using a
single linear mode as the initial perturbation, we numerically simulate
the subsequent nonlinear evolution. Our first computations use a
radiative loss function characteristic of the solar corona. The mode
typically continues growing at approximately the linear rate for several
e-folding times into the nonlinear regime. For initial temperatures in
the radiatively unstable regime (radiative losses decrease with
increasing temperature), the mode saturates when the temperature
decreases sufficiently that the mode stabilizes. Results for multiple
modes in the initial state and for a wide range of parameters will also be
presented.

*Research supported by NASA and NSF. Computations performed at
NCAR and SDSC.

28.03
Detailed Nonlinear Analysis of Vertical Slot Convection*
A. McAllister, R.S. Steinolfson, and T. Tajima (U. Texas, Austin)

In a vertical fluid layer in a vertical gravitational field, a uniform
horizontal temperature gradient causes fluid convection at any nonzero
Grashof number. Linear theory predicts that this primary convection
(an asymptotically 1-D solution) becomes unstable to a secondary
(perturbed) 2-D flow above a critical Grashof number. Using a fully
nonlinear 2-D hydrodynamic code, we have produced simulated
secondary flows consistent with experimental results and quasilinear
theory. However, these secondary flows develop at Grashof numbers
below the linear critical value. We also have evidence of competition
between the fundamental perturbation frequency and its higher order
harmonics.

In order to examine this instability in greater detail we analyze the
equations on a term by term basis to identify which terms dominate
during the rise of the instability. This analysis is carried out at all grid
points to show the spatial dependence of the growing perturbation.
Possible applications to solar and astrophysical plasmas will be
discussed.

*Research supported by NASA and NSF. Computing done at San
Diego Supercomputer Center.

28.04
Two-Dimensional MHD Model of Emerging Magnetic Flux in the Solar
Atmosphere*
K. Shibata and T. Tajima (U. Texas, Austin), R. Matsumoto (U.
Kyoto, Japan)

The undular mode (k, B) of magnetic buoyancy instability (Parker
instability) in the horizontal magnetic flux has been considered to be the
cause of formation of sunspots and active regions. We extend our
previous work (AAS 171st Meeting, 1988) to explain the fundamental
dynamics observed in emerging magnetic flux in the solar atmosphere.
Two-dimensional MHD code is used to study the nonlinear evolution
of the instability in isolated horizontal magnetic flux imbedded to a two-
temperature layered atmosphere (solar corona-photosphere -
photosphere). The two-dimensional flux sheet with B = 1 is initially
located in the lower temperature layer (photosphere). As the instability
develops, the gas slides down the expanding loop, and the evacuated
loop rises due to enhanced magnetic buoyancy. In the nonlinear regime
of the instability, the expansion of magnetic loop tube (arch) show self-
similar type behavior; the rise velocity of a magnetic loop and the local
Alfvén speed at the top of the loop increase linearly with distance. The
rise velocity of magnetic loop in the high chromosphere (h = 6000 -
6000 km) is about 10-15 km/s, and the velocity of downflow along the
loop is about 30-50 km/s, both of which are consistent with observed
values for Arch filament system. Numerical results also explains some
observed features of emerging magnetic flux in the photosphere; such
as strong downdrafts associated with the birth of sunspot pores, and
the small rise velocity of emerging magnetic flux tube in the
photosphere. The effects of magnetic shear, interaction and
reconnection with network fields are also discussed.

*Work supported by DoE, NSF, and NASA.

28.05
Interaction of Freely and Obliquely Propagating MHD Wave
Trains with the Heliospheric Current Sheet
S. T. Suess and Z. E. Musielak (NASA Marshall Space Flight
Center)

We describe the Heliospheric Current Sheet (HCS) as an
isothermal, compressible and low beta magnetic structure
in which the magnetic field changes direction as well as
strength. The medium outside the HCS is assumed to be
homogeneous with a uniform magnetic field, thereby sup-
porting freely propagating magnetohydrodynamic (MHD) wave
tains. If these waves propagate obliquely to the HCS,
they interact with the sheet and are transmitted,
refracted, or reflected. It is shown that reflection takes
place for those wave frequencies that are lower than a

© American Astronomical Society • Provided by the NASA Astrophysics Data System